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# The (De)materialization of Criminal Bodies in Forensic DNA Phenotyping

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**Abstract**
Forensic DNA phenotyping is a genetic technology that might be used in criminal investigations. Based on DNA samples of the human body found at crime scenes, it allows to infer externally visible characteristics (such as eye, hair and skin colour) and continental-based biogeographical ancestry. By indicating the probable visible appearance of a criminal suspect, forensic DNA phenotyping allows to narrow down the focus of a criminal investigation. In this article, drawing on interviews with forensic geneticists, we explore how their narratives translate contemporary focus on criminal molecularized bodies. We propose the concept of (de)materialization to approach three aspects of the forensic geneticists' views. The first regards considering bodies as mutable entities. The second relates to socially contingent meanings attributed to bodies. The third regards to controversies surrounding data reliability. By reflecting upon the (de)materialization of criminal bodies, forensic geneticists juxtapose the defence and unsettling of forensic DNA phenotyping claims.

**Keywords**
criminal bodies, (de)materialization, forensic DNA phenotyping, molecularization

## Introduction

The focus on criminal bodies as readable goes back to the 19th century, with the development of criminal anthropology, which unequivocally marked how the relationship between body and crime is considered. Such an approach is based on the premise that propensity

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for crime is inscribed in the body and materialized in the form of physical, moral, degenerative and inalterable characteristics (Cole, 2001; Horn, 2003; Rose, 2000). Although such perspective was widely criticized and discredited, the rise of genetics and neuroscience has reinvigorated, from the 1960s onwards, the prominence of approaches that attempt to make the criminal body a readable entity (Pavlich, 2009; Rose, 2000; Twine, 2002; Walby and Carrier, 2010).

There has been, however, a significant shift: In the 19th century, the focus resided at the molar body, that is, the visible and tangible body, easily revealed to the gaze of the experts. Nowadays, however, the focus on the body has been supplemented by the molecular level. A multitude of increasingly sophisticated biometric technologies and visualization devices now renders the interior of the organic body readable while simultaneously allowing its decomposition, anatomization, manipulation and amplification at the molecular level (Rose, 2001, 2007). As posed by Nikolas Rose, molecularization involves 'a set of intelligible vital mechanisms ( . . . ) that can be identified, isolated, manipulated, mobilized, recombined, in new practices of intervention, which are no longer constrained by the apparent normativity of a natural vital order' (Rose, 2007: 5–6). As a result, attempts to render the criminal bodies as readable are increasingly anchored on the molecularization of the body (Duster, 2003).

The goal of this article is to understand how contemporary focus on the criminal body engages and combines, in fluid and hybrid ways, notions of molecularization of the body and the molar body. Based on a set of interviews with forensic geneticists who work in the development and provision of genetic tests in criminal cases in different European countries, we explore the constructions of the criminal body implied in one specific genetic technology: forensic DNA phenotyping.

Forensic DNA phenotyping is a set of techniques that aim to infer externally visible characteristics of the human body (such as eye, hair and skin colour) and continental-based biogeographical ancestry (i.e. belonging to larger genetic populations) of an unknown person, based on biological material found at crime scenes (Daniel et al., 2015; Kayser, 2015; Kayser and de Knijff, 2011).[1] Forensic DNA phenotyping has been applied in various jurisdictions in a limited number of high-profile cases, to provide valuable information for criminal investigations (Wienroth, 2018a). Its use is expected to

allow narrowing down the focus of a criminal investigation by targeting groups of individuals sharing a set of body traits.

Approaches based on the new configurations of bodies brought by the advent and consolidation of genomic science and molecularization of the body (Rose, 2007: 5–6) have so far been absent from the social sciences literature on forensic DNA phenotyping. The initial debate in the social sciences field about this genetic technology has primarily focused on the socio-ethical challenges that might emerge from its use in the criminal justice system. We summarize the current discussion around three main topics.

The first relates to the ethical challenges of targeting suspects based on genetic inferences of physical appearance. For a criminal investigation, this means that similar-looking people are grouped in a 'suspect population' (Cole and Lynch, 2006). Consequently, this implies that once included in such a 'suspect population' law enforcement must prove that a particular individual is innocent (M'charek et al., 2012). One of the forms of achieving this is through the application of other forensic investigative techniques, such as massive screenings (Thomas, 2006). In brief, massive screenings are exceptional procedures that involve collecting DNA samples from 'volunteers' who are members of a particular group to search for potential suspects among that population's members (for a critical perspective of the uses of this technique, see Ossorio and Duster, 2005). By coupling massive screenings with forensic DNA phenotyping, it is possible to collect DNA information from a group of individuals whose visible traits correspond to the ones attributed to the unidentified DNA sample found in the crime scene. However, such modus operandi raises considerable ethical and legal concerns related to the presumption of innocence and the non-interference from law enforcement actors in the absence of individualized suspicion (Toom et al., 2016).

A second interrelated topic of the socio-ethical debate over forensic DNA phenotyping concerns its potential to reproduce stigmatization and reinforce criminalization. Forensic DNA phenotyping relies on fluid patterns of genetic difference and sameness (M'charek et al., 2013). Consequently, the application of this technology might increase the visibility of racial or ethnic differences, thereby affecting population groups already vulnerable to the action of the criminal justice system, such as racial and ethnic minorities (M'charek, 2008;

M'charek et al., 2012; Queirós, 2019; Sankar, 2010; Skinner, 2018a, 2018b; Toom et al., 2016).

The third topic under discussion regards the socially decontextualized nature of the information provided by forensic DNA phenotyping. Some proponents of this genetic technology have been arguing that it should be considered as akin to a 'biological witness', with the potential of providing more accurate information than traditional eyewitnesses due to its technoscientific character (Kayser, 2015). In response, critics outline that, while forensic DNA phenotyping might provide information about a person's most likely appearance, it is not able to provide other relevant contextual information about the events of a crime, as an eyewitness' account would (Toom et al., 2016). Other studies also approached the ethical, operational and commercial issues associated with forensic DNA phenotyping for social actors with a professional stake in this technology (Samuel and Prainsack, 2018, 2019; Wienroth, 2018a, 2018b).

The use of forensic DNA phenotyping in the criminal justice system is currently framed in a context marked by a complex politics of legitimation and contestation (Skinner, 2018b). Consequently, we argue that it is vital to understand how forensic geneticists reflect upon such genetic technology. Besides being responsible for the development and application of forensic DNA phenotyping, these professionals hold the power of not only shaping its regulation but also consolidating and/or unsettling its claims in the scientific and legal realms.

## (De)materialization of Criminal Bodies

We propose the concept of (de)materialization of criminal bodies to approach the constructions of criminal bodies implied in forensic geneticists' views. Our focus lies on understanding the meanings attributed by forensic geneticists to scientific practices oriented to infer particular body characteristics of a criminal suspect, such as eye, skin and hair colour, and biogeographical ancestry.

We take inspiration from scholarship on the body (DeMello, 2014; Lock, 1993; Mol, 2002; Synnott, 1993) and from a set of contributions that have critically explored the association of forensic science with materiality (Kruse, 2016; M'charek, 2013). More particularly, we follow Corinna Kruse's approach to the materialization of the

body in forensic science. According to Kruse's view, 'rather than *making use* of the body's materiality, forensic science, together with law enforcement and legal practices, *materializes* the (criminal) body at the same time as it establishes the connection between a particular body and a particular crime scene' (Kruse, 2010: 2).[2] Kruse focuses on the traditional DNA profiling method, which serves an individual identification purpose. That is, if the DNA found at the crime scene corresponds with the DNA of a given individual, there is the identification of a potential suspect. In this article, we aim to expand the association of forensic science with materiality by focusing on forensic DNA phenotyping. This is a technology that moves the locus from individualization (i.e. identification of specific individuals) towards collectivization. It does so by clustering suspect populations that share genetic ancestry and/or externally visible characteristics.

Conceiving materialization within forensic science as an activity that involves and is co-constituted by matter, technoscientific practices, legal framings and cultural understanding (Kruse, 2010), we propose the concept of (de)materialization of criminal bodies. Such a concept is particularly useful to approach the views of forensic geneticists on forensic DNA phenotyping because it demonstrates how such professionals juxtapose the defence and unsettling of forensic DNA phenotyping claims.

Applied to the particular case of forensic DNA phenotyping, the materialization of criminal bodies refers to actions and scientific procedures that allow inferring genetic information related to externally visible characteristics of a human body and continental-based biogeographical ancestry of an unknown person. Implicit to such materialization is an approach to the human body as a collection of 'detachable things' (Blackman, 2010; Waldby, 2002): eye, hair and skin colour, as well as biogeographical ancestry. In this sense, forensic DNA phenotyping does not materialize whole bodies, but particular bodily constellations that are regarded as potentially relevant to advance criminal investigations.

The dematerialization of criminal bodies regards how forensic DNA phenotyping is unable to serve as an individual identification purpose. Dematerialization entails two main interrelated dimensions. The first regards how the molecularized approach to bodies is resolutely reductionist since the significance of historical, cultural, sociopolitical and environmental aspects remain mostly unaccounted for

(Lock, 2013). An approach to the dematerialization of criminal bodies considers the concept of 'the embedded body' developed by Jörg Niewöhner in the context of epigenetics. In his words:

> The emerging embedded body is a body far more 'open to the world', and it responds to the world not only by letting matter and meaning pass through its 'inner laboratory'. The embedded body is not a machine that runs on input from the world by metabolizing it without being affected. Rather, the inner laboratory itself is changed through operating in an embedded body. (Niewöhner, 2011: 12)

The 'embedded body' suggests a distinctive degree of entanglement between material and social, that transgresses the paradigm in which the body is viewed as acontextual (Irni, 2017; Latimer, 2013). In this sense, the body is seen as much more than a passive biological material (Bjørn and Markussen, 2013; Lykke, 2010) that can be accessed, read, materialized and appropriated through increasingly sophisticated technologies. The 'embedded body' is, therefore, a particularly useful concept when considering the dematerialization of criminal bodies in forensic DNA phenotyping as it translates the ways whereby bodies are affected by and, simultaneously, the effect of embodied social relations, local practices and power relations. In other words, how bodies are socially situated and contingent (Butler, 1993; Irni, 2017).

The second interrelated dimension of the dematerialization of criminal bodies relates to how molecularized notions of the body are not homologous with its social or cultural understandings (M'charek et al., 2012). For example, stating that the molecular analysis of the body shows that the criminal suspect is possibly from 'African ancestry' is probably going to be translated by non-experts – such as police officers and the general public – as 'the suspect is probably black' (see also Samuel and Prainsack, 2018). The concept of dematerialization thereby sheds light on how molecularization intersects with molar conceptions of the body. In addition, the concept also allows exploring how such interaction between molecular and molar conceptions is heavily influenced by technoscientific practices, legal views, and social and cultural influences and understandings about what a criminal body is.

This article is based on a broader project that explores the societal, cultural, ethical, regulatory and political impacts of the use of

forensic DNA technologies in the European Union (EU). This study utilizes a multi-methodological approach that includes the collection and analysis of stakeholders' views, and a review of the literature in the domain of forensic genetics. We conducted individual interviews between March 2016 and June 2017 with 19 forensic geneticists based in 12 different European countries.[3] To protect the anonymity of the interviewees, we identified the country in which each interviewee is based using a letter. We use this form of anonymization in the interview quotations analysed in the following sections.

Considering the diversity of the forensic genetics community (Cole, 2013; Lynch et al., 2008), we adopted the following selection criteria to recruit the participants for this study: holding a degree in a discipline directly connected to forensic genetics (e.g. biology, genetics and medicine), and being the head researcher or employee of a forensic laboratory that provides DNA analysis that is presented as evidence in criminal cases. Consistent with Simon Cole's categorization, our sample aggregates 'forensic genetic scientists', that is, individuals working on criminal cases and that are employed by a forensic laboratory, and 'research scientists', which represent individuals employed by universities whose primary professional occupation is scientific controlled laboratory research with applications in forensic science (Cole, 2013). We selected interviewees by consulting lists of members of professional networks and consortiums within the field of forensic genetics, such as EUROFORGEN[4] and VISAGE.[5] The selection process also involved the search of authors of scientific articles in the field of forensic genetics and contacts with professionals participating in conferences and other events relevant to the field.

We conducted the interviews under the protocols and procedures of the European Research Council's ethics regulations. Participants were recruited by email, letter and telephone calls. Before the interviews, all interviewees signed a written informed consent form and agreed to be audio recorded. Fifteen interviews occurred in the workplace of the participants, two via Skype, one during a forensic science congress and one by phone. On average, the interviews were 90 min long. All interviews were digitally recorded, transcribed verbatim and anonymized. We edited the quotations whenever necessary to assure clarity of language while respecting integrally the meaning manifested by the participants' words (Bertaux, 1997).

The script of the interviews covered the following themes: the organization of the provision of forensic genetics services in the country where the participant was based; views and experiences regarding the transnational exchange of DNA data in the EU; representations of public engagement with forensic genetics; and perceptions concerning DNA technology developments and innovations. In this article, we explore the interviewees' views only concerning forensic DNA phenotyping. Although we use such term, to avoid narrowly framing the topic under analysis, during the analysis, we also identify other terms similarly used by interviewees, such as 'externally visible characteristics', 'biogeographic ancestry' and 'ancestry informative markers'.

Relevant quotations about forensic DNA phenotyping were coded and subjected to multiple readings. These quotations were systematically compared, contrasted, synthesized and coded by theme and thematic category following the principles of grounded theory (Charmaz, 2006) and interpreted using a qualitative content analysis approach (Mayring, 2004). In this article, we analyse quotations considered by the authors as illustrative of each thematic category that emerged from the content analysis.

## Mutable Bodies

Body studies have made considerable contributions to problematize bodies as biologically given by outlining that bodies do not constitute a stable entity that remains unsettled over time; instead, they are subjected to change throughout life (Butler, 1993; Haraway, 1991). Such change can be enacted through voluntary intervention and/or through bodies being exposed to and altered by environmental influence (Lock, 2013; Meloni, 2018; Niewöhner, 2011).

Considering bodies as an active process that changes over time evidence how individuals might manipulate their bodies to actively modify their appearance via cosmetic treatments and/or plastic surgeries. Such conception of body's mutability is present in interviewees' accounts when outlining the potential limitations of forensic DNA phenotyping. As explained by one participant of our study, the process of ageing and/or interventions made to the body might pose challenges to the use of this technology in criminal investigations:

> It is all very well to say we can predict what the other person might look like, but looking at some of my photographs when I was a youngster, my DNA was certainly the same, but I looked very different. I would argue that you would struggle to pick me out. (. . .) And, of course, there may be things like cosmetic treatments (. . .). So, I wonder really whether it [forensic DNA phenotyping] is going to be useful as an investigative tool. (D12)

Interviewees tend to highlight how the information produced by forensic DNA phenotyping mainly addresses a molecularized version of the body that underplays the complex relations between biological matter, technoscientific practices and culture. Such perspective is associated with the recognition of how the increasing importance of biosciences in the second half of the 20th century is rebuilding the biological 'in ways that make it more social than "natural"' (Franklin, 2003: 65). As a result, our participants outline how molar bodies might appear to be something completely different from the predictions based upon a molecularized approach:

> We are increasingly able to use cosmetics and small surgeries and lifting [procedures], and we can change the appearance a lot. I call that Michael Jackson syndrome. Michael Jackson, when he was a small boy, you would call him an (. . .) Afro-American (. . .). In addition, when he was dying, it was very difficult to say what he was. (N01)

The interviewed forensic geneticists tend to perceive bodies as mutable entities that should be considered as such when addressing the potentialities and risks of forensic DNA phenotyping. Such an approach implies conceiving the interferences that interdependent elements – social, cultural and biological – can produce in 'the embedded body' (Niewöhner, 2011). As explained in the following quotation, a strictly molecular-driven perspective is not helpful to address forensic DNA phenotyping results, as elements such as age and hair colour have interdependent effects throughout the life course:

> If he [potential suspect] is 20, he will have a lot of hair. However, the same suspect at 40 may have no hair. [Meanwhile, he might also] start to develop grey hair. Because I had dark brown hair 20 years ago but now it is greying. (P02)

Nevertheless, according to the participants in our study, the recognition of body's mutability does not imply that the forensic utility of forensic DNA phenotyping is threatened. Such an acknowledgement provides the basis for the perceived need for the development of anticipatory approaches and practices (Wienroth, 2018a) that remain vigilant to the potential interference of biosocial environments into bodies. An interviewee discusses the operational implications of such considerations in the following quotation:

> Concerning the determination of phenotypic characteristics, it can be very complex, as phenotypic characteristics don't depend exclusively on genetics; they also depend on what we eat, the air we breathe, epigenetics and plenty of other factors, so it's not going to be an easy approach. (. . .) We can say it's likely that the individual has blue eyes since he has the corresponding gene, but the interpretation of that, within the test, well, it's possible that the individual had blue eyes because in the day of the robbery he wore blue contact lenses or something like that. (C01)

Forensic DNA phenotyping is emerging and developing at a time when, due to a wide range of technological developments, the molecular domain is more readable than before (Rose, 2007). Simultaneously, it is also a time where the biological is increasingly more social (Franklin, 2003; Meloni, 2018) – that is, rendered as increasingly mutable and open to interference (Rose, 2007). This juxtaposition is constitutive of the (de)materialization of criminal bodies as it outlines how biology is not as a pregiven destiny but an opportunity to act upon (Rose, 2007). Within forensic DNA phenotyping, this implies that forensic geneticists operate under the tacit recognition that, even if forensic DNA phenotyping is used in criminal investigations, there is always the chance that the molecular inference of physical features might not correspond to the molar body's current appearance.

## Ascribing Meaning to Matter

Associated with the notion that bodies are mutable, interviewees also acknowledge the embeddedness of bodies into environmental, historical and sociopolitical contexts (Lock, 2013; Niewöhner, 2011). More particularly, while considering the uses of forensic DNA phenotyping, participants of this study recognize how molecularized

inferences of bodies' appearance cannot be read separately from the context in which they are situated. As the following quotation highlights, the same type of biological matter (i.e. the same skin or hair colour) might acquire different meanings, according to the social and geographical contexts where it is being framed:

> There are a few places where looking at changes in hair or skin colour might tell you something, but if you go to most parts of the world, you go to Portugal and you say "Someone has got dark hair and Mediterranean skin." It is like, "OK, great. I will exclude this guy, but the rest of the population is still in" [laughs]. (D10)

Meanings attributed to matter are, thus, considered as highly contingent on its broader social, geographical and cultural framing. Consequently, according to different contexts and the particular characteristics of specific populations and communities, the benefits of using forensic DNA phenotyping to assist criminal investigations might appear as minor or highly valuable. As the following participant explains, benefits might be somewhat limited in countries/towns scarcely affected by the mixing of different populations:

> Usually, people doing research are using these ancestry markers (. . . ), but people are thinking in a multi-ethnic environment – maybe [forensic DNA phenotyping] it's useful [there]. So far, we don't have a very multi-ethnic environment [in this country]. (. . . ) However, in big cities, I think it's important, especially if you have a serious crime and an unknown criminal. (J02)

The materialization of criminal bodies thus might acquire different meanings according to particular socio-geopolitical contexts. As the following participant explains, if the inferences produced by forensic DNA phenotyping are not significantly different from the characteristics of the rest of the population of a specific location, the results might be almost useless:

> [Biogeographic ancestry] may be useful, but it may also be useless. For example, if the investigation results show that this is a typical European genetic background, what do you know? You know that the person is European. So maybe you can exclude some Africans and some people from the Middle East or some other areas, but that is about it. On the other hand, if you know that somebody came from

> South Asia or Afghanistan, like in that particular case, then you might look more into a particular group of people. (O01)

The materialization of bodies through forensic DNA phenotyping is, therefore, contextually contingent. As such, articulations of difference and sameness become entangled with specific bodies and places (Hinterberger, 2012; M'charek, 2010). That is, using the example provided in the previous quotation, identifying the suspect as someone with European ancestry might imply that, within the context of a criminal investigation, all individuals belonging to that group would be considered potential suspects by association (Machado and Granja, 2020).

Forensic DNA phenotyping thereby works as a technology of collectivization (Queirós, 2019; Skinner, 2018a) by drawing individuals together into a fluid collective configuration of suspicion, even in the absence of individualized suspicion derived from past or present behaviour. Such modus operandi stands in opposition to other biometrical systems, such as fingerprints and traditional DNA profiling techniques (Kruse, 2010). Instead of materializing a particular criminal body, and individualizing suspicion, forensic DNA phenotyping points towards social groups and populations sharing the same biological traits (M'charek, 2008). In this sense, this genetic technology implicates dimensions of time, space, technoscientific practices, legal views and cultural understandings in ways that enlarge the scale of who is considered a potential suspect. Besides, the collective configuration of suspicion made possible by the use of forensic DNA phenotyping also has the potential to reproduce patterns of discrimination, as exposed by the following interviewee:

> I think this [estimate of aspects of phenotype] is quite ethically sensitive, and it probably has broader connotations in the sense that if you are finding aspects of phenotypes when you are in a country where these might relate to a particular ethnic group or ethnic minority, then evidence sensitivity occurs. (D11)

The use of forensic DNA phenotyping in criminal investigations, therefore, infuses new dynamics into the much-discussed relationship between racialization (i.e. explicit talk of races and ethnicities) and racism (patterns of discrimination and structures of

disadvantage) (Skinner, 2018a: 8). First, because the materialization of criminal bodies within forensic DNA phenotyping conveys a molecularized approach that reinforces notions of genetic sameness (Ossorio, 2006; Skinner, 2018a, 2018b) under the aegis of forensic sciences alleged objectivity (Lynch et al., 2008). Second, by clustering suspect populations based on their shared molecular traits and signifying them in a contextual-contingent manner, forensic DNA phenotyping holds power to reinforce the criminalization of minority groups (M'charek et al., 2012; Skinner, 2018a). Such risk is acknowledged by some interviewees, who refer to the potential of collective stigmatization within the use of forensic DNA phenotyping:

> There is a risk of stigmatization of communities. ( . . . ) You go across to a place like Bradford, and there are a lot of cases where Asian men are grooming vulnerable white girls. So, if you have situations like that, then saying "OK, we are looking for an Asian man" gives fuel to people who want to do harm within the community. So, that is a danger. (D10)

The (de)materialization of criminal bodies in forensic DNA phenotyping establishes sameness and dissimilarity in ways that are consistent with situational social constructs of race and ethnicity. Consequently, (de)materialization is closely related to the constant interplay between structural inequalities and accounts of difference (Van der Meer and Tolsma, 2014).

## Data Reliability

The development of forensic DNA phenotyping leads some forensic geneticists to establish a direct comparison between information provided by traditional eyewitnesses and data retrieved from DNA using this technology. This comparison reveals two primary forms of materializing criminal bodies within criminal investigations. One form relates to the materialization of criminal bodies through information provided by humans, that is, eyewitness testimonies. In contrast, the other form of materializing bodies involves undertaking a molecular analysis of the body that aims to infer some visible traces, that is, forensic DNA phenotyping. The narrative of the following participant expresses the perceived differences between eyewitness testimonies and forensic DNA phenotyping in terms of data reliability:

> All of these tests collectively are aimed at providing an alternative to eyewitnesses. Because sometimes investigators (. . . ) have eyewitness accounts that conflict or there is some irregularity or inconsistency in people's accounts. In addition, eyewitness accounts are generally quite unreliable. So, it is good to have a genetic test to back up what people have claimed to see. (C04)

Eyewitness testimonies and forensic DNA phenotyping use different methods and imply distinctive modes of assessment. Nevertheless, its direct comparison is quite recurrent both in the literature (Kayser, 2015; Walsh and Kayser, 2016) and in interviewees' narratives as a way to highlight the potentialities of forensic DNA phenotyping. According to forensic geneticists' accounts, the main difference between these two forms of materializing criminal bodies relies on their differentiated degrees of reliability. Adopting a narrative highly infused by self-serving bias, participants of this study refer to eyewitness accounts as fragile, pervaded with emotions, motivations, subjectivities and informational gaps. By opposition, forensic DNA phenotyping is described by forensic geneticists as being incorporated under the aegis of the alleged objectivity of forensic science and, thereby, considered as more neutral and immune to social bias (Lynch et al., 2008). This argument is clearly expressed in the following quotation:

> I don't find any difference between a testimony, generally accepted, which might provide an opinion, because this is the investigative stage. A testimony that says "The crime was committed by a man. I believe he was 50 years old. His hair had a certain style. To me, he looked Islamic because he had a lot of that . . . ." Those are the types of features the police should ask about. (. . . ) Moreover, another thing judges also don't know and should be informed about [is] the huge mistake of the so-called testimony identification stage, which presents one of the most serious judicial problems in the world. (C05)

The presumed reliability attributed to forensic DNA phenotyping data is, however, challenged when it is not posed in direct comparison with eyewitness testimonies. As social studies of science have demonstrated over the years, forensic science results, characterized by the appearance of a technical order, stand in clear contrast with the 'messiness' of laboratory practices where tests are performed (Lynch, 2002). As such, it is crucial to keep in mind how, during

scientific knowledge production, data are continuously lost, filtered and transformed (Kloppenburg and van der Ploeg, 2018).

In addition to the contingencies inherent to the production of scientific knowledge, the unreliability of forensic DNA phenotyping is also a significant point of discussion. First, because forensic DNA phenotyping entails a process that aims to materialize the criminal body by collecting a set of 'detachable things' (Blackman, 2010; Waldby, 2002): eye, hair and skin colour, and biogeographic ancestry. In such a process, each physical characteristic introduces a certain degree of contingency and the associated margin of error (Kloppenburg and van der Ploeg, 2018). In addition, some results, such as biogeographic ancestry, might reveal mixed heritage. Second, forensic DNA phenotyping relies on a computerized comparison that uses reference databases with variable composition, representativeness and organization (Skinner, 2018a). Many of these reference databases are likely to have cohort biases. Third, forensic DNA phenotyping inferences might also vary due to the differentiated quality of prediction algorithms that are being used (Scudder et al., 2019).

As several factors influence the process and shape its outcomes, results of forensic DNA phenotyping are not communicated by forensic geneticists as a definitive certainty ('the criminal suspect has blue eyes'). Instead, they are communicated as a score of a threshold of probabilistic accuracy about each physical feature (i.e. 'it is 70% probable that the suspect has blue eyes'). Such a form of communicating results complicates its subsequent interpretation, as police and prosecutors need new skills and knowledge to assess them properly. That is, in ways that mitigate the potential for confirmation bias (Skinner, 2018a). Pursuing a false lead, influenced by an erroneous interpretation of forensic DNA phenotyping results, might waste police resources and contribute to consolidating a patterned bias towards the criminalization of certain racial and ethnic groups. Given the risk of leading to severe miscarriages of justice (Ossorio and Duster, 2005), interviewees state that, although forensic DNA phenotyping might be potentially useful for criminal investigations, it should be restricted to the investigatory stages, and backed up by complementary information:

> [These investigative tools] will predominantly be used only in the investigative phase of a case, so they will only be used by the police in order to get additional information from unknown suspects. As

> such, you can directly compare them with witness statements. Only the DNA tools are a little bit more accurate than witness statements. In addition, they will probably enable the police to more accurately focus on a limited number of possible suspects – and that is it. So, once suspects have been identified, normal routine DNA research is needed to match them to DNA samples from crime scenes. So, these additional techniques are only investigative tools. I do not see a lot of risk in that. (A03)

This perceived need for the corroboration of results is mainly associated with the perception of forensic DNA phenotyping as an open box, which indicates that professionals are still in the process of building up and breaking down controversies over this genetic technology (Samuel and Prainsack, 2018, 2019; Wienroth, 2018a, 2018b). In this sense, despite certain participants arguing that the use of forensic DNA phenotyping is much more reliable than eyewitness testimonies, the hidden and unsettled operational basis of science in the making calls for circumspection about the potential impacts of its results. Ongoing research aimed at improving predictions still faces as a limitation the inextricable entanglement of biology with both the environment and the social order (Lock, 2013). As the following participant explains, the potential unreliability of the findings must be considered:

> We need to be circumspect about their reliability, circumspect about its power in distinguishing a phenotype or appearance from another, and aware that it probably has no probative value at all. So, it is just another factor that could guide an investigation, but we need to be aware that it is not very reliable. So, it might help us a bit, but we have to remember that it might not be quite right, so you must not exclude the other possibilities. (D11)

Despite already playing a pivotal role in the way certain criminal investigations are conceived of and performed (Wienroth, 2018a: 4), forensic DNA phenotyping has not yet reached a scientific consensus that might robustly attest to its use as sole evidence within criminal courts. As a result, as the following interviewee notes, participants in this study argue that findings should be restricted to guide criminal investigations:

> I think there needs to be a lot of distinction made with regard to investigative and prerogative value, and reliability. If you have a

> DNA test that can predict whether somebody has dark skin, dark hair and dark eyes and it is right 66% of the time, it might be a bit helpful to an investigation. Although, of course, you have to bear in mind the third of the time that it is going to be wrong. In addition, it is not probative either and does not prove unequivocally what the person is going to look like. (D11)

Interviewed participants thus (re)shape the character of unresolved science vis-à-vis the non-scientific domains in different ways. First, the participants construct boundaries that divide between two forms of materializing criminal bodies: eyewitness and biological testimonies. Based on such a divide, interviewees argue that forensic DNA phenotyping might be a more useful tool due to its technoscientific character. Secondly, the interviewed forensic geneticists take a participant role in the controversies surrounding the unreliability of forensic DNA phenotyping results. Given the lack of consensus within the scientific community (Wienroth, 2018b), interviewees attest that this technology is currently not sufficiently robust to formulate a black-boxed knowledge. Forensic DNA phenotyping is, thereby, placed in a 'liminal space'. That is, 'an in-between state, in which the values and the norms of one stage have been left behind and the values and the norms of the later stage have not yet been reached' (Derksen, 2010: 221). In other words, forensic geneticists' views outline that the materialization of criminal bodies coexists with its dematerialization due to unresolved issues of unreliability within forensic DNA phenotyping results.

## Conclusion

Taking inspiration from scholarship on the body (DeMello, 2014; Lock, 1993; Mol, 2002; Synnott, 1993), this article aims to contribute to advance the reflection on the molecularization of the body (Rose, 2007) by focusing on the particularities of rendering criminal bodies as readable. Our approach also allows for expanding contributions that have previously critically explored the association of forensic evidence with materiality (Kruse, 2016; M'charek, 2013). We move the locus of discussion from traditional DNA technologies focused on individualization (i.e. identification of specific individuals) towards emerging technologies that entail dynamics of collectivization of suspicion. More particularly, we focus on forensic DNA phenotyping, a genetic technology that

enables the clustering of suspect populations based on shared externally visible characteristics and/or biogeographical ancestry.

By adopting such a theoretical approach, we demonstrate that current endeavours to conceptualize forensic DNA phenotyping technology can be enriched by reflecting upon the material-technoscientific-cultural practices involved in the construction of criminal bodies. Such perspective aims to underline that theoretical conversations across body studies and science and technology studies focused on forensics should be understood and conceptualized as mutually contributing to each other.

We base our analysis on the narratives of forensic geneticists who work in the development and provision of genetic tests in criminal cases in different European countries. In a context framed by a complex politics of legitimation and contestation over the use of forensic DNA phenotyping in the criminal justice system (Skinner, 2018b), it is clear that forensic geneticists' individual, as well as collective, views are an emergent product of social interaction. This perspective helps to conceive forensic geneticists' narratives as a social construct and to see how such professionals relate not only to their views but to those of others. In this sense, although forensic geneticists argue that forensic DNA phenotyping might materialize particularly bodily constellations that are regarded as potentially relevant to advance criminal investigations, they also acknowledge and account for how such materialization might be challenged. First, due to the inability to molecularly infer all the changes that might be acted upon molar bodies.

Second, because molecularized inferences and molar bodies might acquire different meanings according to environmental, historical and socio-geopolitical contexts in which they are framed. By acknowledging such socially embeddedness nature of bodies, forensic geneticists also take into account how forensic DNA phenotyping might reinforce structured inequalities linked to discrimination and stigmatization of racial and ethnic groups. This is a topic that has been heavily discussed by social scientists critically addressing the use of forensic DNA phenotyping in the criminal justice system (M'charek, 2008; Sankar, 2012; Toom et al., 2016). Moreover, the fact that forensic geneticists exhibit concerns about the risk of discrimination and stigmatization raised by forensic DNA phenotyping reveals dynamics of social interaction. That is, the concerns about these risks are part of the social repertoire and collective expectations

(Konrad, 2006) framing the use of forensic DNA technologies within the criminal justice system.

Finally, forensic geneticists also address the contingencies connected to science in the making, and the inherent challenges of interpreting forensic DNA phenotyping probabilistic results (Skinner, 2018a). While acknowledging the potentially pivotal role of forensic DNA phenotyping in specific criminal investigations, the interviewees also outline how molecularized inferences might not correspond to the molar body's current physical appearance. In this context, forensic geneticists argue that forensic DNA phenotyping should be restricted to criminal investigation purposes, and not used as forensic evidence.

In sum, this article helps to understand how forensic geneticists' narratives juxtapose the defence of forensic DNA phenotyping potential to advance criminal investigations, while simultaneously unsettling some of its claims. By continually engaging and combining, in fluid and hybrid ways, notions of the molar body and the molecularization of the body, forensic geneticists respond to what they perceive as being the main contingencies of forensic DNA phenotyping in manners aimed at protecting their field of expertise.

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## Notes

1. For this article, we excluded the potential uses of this technology in the search and/or identification of missing persons.
2. Original italics maintained.
3. The countries where the interviews were conducted are Czech Republic, Germany, Hungary, Malta, Norway, Poland, Portugal, Romania, Slovenia, Spain, the Netherlands and the United Kingdom.
4. https://www.euroforgen.eu. The EUROFORGEN Consortium includes 16 participating institutions from 9 European Union Member States, including leading groups in European forensic genetic research.
5. http://www.visage-h2020.eu/#about. The VISAGE Consortium consists of 13 partners from academic, police and justice institutions of 8 European Union Member States and brings together forensic genetic researchers and forensic DNA practitioners, statistical geneticists and social scientists.

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